Depopulation

Background.

Based on the science presented in this document and consultation with CWD experts across the country, the best strategy to eradicate CWD from an affected area is to reduce the deer herd in the affected area to near zero. This prevents transmission of the disease both within and outside of the affected area, lowers the population of susceptible animals below the threshold that the disease can persist, and prevents the infectious agent from being shed into the environment. Although the population level below which the disease can persist is not known, the disease has persisted in Colorado with densities as low as five to six deer per square mile (equal to 10 deer per square mile of deer habitat in Wisconsin). Therefore a goal of near zero is expected to be beneath the population level that the disease can persist.

The basis for a population goal of zero deer to eradicate disease is that models of CWD epidemiology (Gross and Miller 2001) and current understanding of the disease (Williams *et al.* 2002a) suggest that CWD is a uniquely difficult disease to manage. Epidemiological models of CWD in mule deer suggest that stable equilibria of CWD prevalence within infected populations of mule deer are unlikely (Gross and Miller 2001). These models suggest the prevalence of CWD in infected mule deer populations will either increase and exterminate the deer population, or at very low prevalence and low transmission rates, will decline and disappear. Similarly, the Wisconsin model of CWD dynamics in white-tailed deer suggests high prevalence and dramatic population declines if CWD is allowed to spread unchecked for 20 years (John Cary, Univ. of Wisconsin, pers comm.). Long incubation, subtle early clinical signs, absence of a practical live test, an extremely resistant infectious agent, possible environmental contamination, and incomplete understanding of transmission constrain options for controlling or eradicating CWD (Williams *et al.* 2002a). Selective removal of clinical suspects in Colorado and Wyoming has failed to reduce prevalence. Localized population reduction is being tried for areas where infection is thought to be relatively recent, but the effectiveness of this technique remains unknown (Williams *et al.* 2002a). Models suggest that early, aggressive interaction via selective removal or more generalized population reduction show the greatest promise in preventing new endemic areas from being established (Gross and Miller 2001).

The length of time that an affected area would need to be kept free of deer to insure local eradication of CWD is unknown. The anecdotal evidence of CWD infection from contaminated environments (Williams *et al.* 2002a) and the unknown importance of environmental infection in maintaining CWD epidemics (Miller *et al.* 2000) drive the issue. A distinctive property of abnormal prions is resistance to many disinfectants and inactivation procedures typically used to destroy infectious agents. Also, multiple strains of TSE agents have been identified, even within a particular disease group and some strains are more resistant to inactivation than others. With respect to CWD, it is unknown whether there are multiple strains and what relative degree of resistance to inactivation CWD has with respect to some of the better known TSEs. Moreover, the issue of the amount of infected material an animal must consume or be exposed to become infected with CWD or any other TSE is not known. Neither is it known if repeated small doses can result in infection. In experimental settings, low-dose inoculations have decreased probability of infection and prolonged incubation periods. In some animal experiments, the incubation period extended beyond the natural life span of the animal; that is, at the time of death due to “natural causes,” the animal was infected with the TSE agent but was not symptomatic (Dickinson 1977; Thackray *et al.*, 2002). Although this is true for some TSEs, it is not known whether this is true for CWD. Fortunately a model of CWD epidemiology calibrated to field data (Gross and Miller *et al.* 2001) and observations indicates that prolonged exposure to highly contaminated environments (more characteristic of captive situations) seems necessary for transmission. Williams *et al.* (2002) suggest that in the absence of practices that replicate captive conditions, infection from contaminated environments is relatively unimportant to sustaining CWD epidemics in the wild.

A closely related issue is what criteria can be used for removal of an area from depopulation status. These criteria have not yet been established. But, for captive herds, a minimum of five years of complete surveillance of all juvenile and adult mortalities is emerging as a standard for demonstrating CWD-free status. The five year standard accounts for uncertain incubation and variation in the clinical presentation and course of CWD (Williams *et al.* 2002a). Surveillance in wild deer is much more difficult, and two scenarios for an affected area are possible depending on the success achieved in getting to a goal of zero deer per square mile. If the deer herd is depopulated, then the only issue is environmental contamination.

Risk analysis would depend on research into prion persistence and the risk of infection from environmental sources that presumably degrade over time. If deer are not eradicated, risk analysis must account for trends in prevalence among the residual deer population in addition to environmental contamination. In the latter case, active surveillance of the residual deer population would be needed. With current technology, surveillance may require a sustained effort over many years because common surveillance techniques (targetted surveillance of clinical deer, and random surveillance of hunter-killed deer) rely on assays that do not identify animals in the early stages of CWD infection (Miller *et al.* 2000, Williams *et al.* 2002a).

Hunting seasons have been the primary tool of deer herd management throughout Wisconsin's history (Dahlberg and Guettinger 1956). Typically, over 700,000 hunters pursue deer each year in this state. In the past, hunters have had the capability of controlling the deer herd at or near population goals established for each management unit. Traditionally, hunting seasons and antlerless deer permit systems had been conservative to protect deer populations and allow them to grow to levels consistent with habitat carrying capacity and human tolerance. Recently, however, hunting harvests have not kept pace with herd growth, and deer herds have not been kept at overwinter population goals (McCaffery 2001). Hunters have been reluctant to support liberalizing hunting seasons and permit systems as they enjoy seeing higher numbers of deer. Yet, October and December four-day antlerless only seasons (Zone T) with free antlerless deer permits have been employed to increase harvest of deer in units where normal hunting seasons and permit systems are not expected to get deer populations to within 20% of overwinter goals. The Deer 2000 citizen participation process also developed an earn-a-buck regulation that will be used when two years of Zone T have not reduced the population to within 20% of goals and a third year of Zone T is not expect to work (Wisconsin Conservation Congress 2001). Unfortunately, even these liberal regulations are not expected to be enough to get hunting harvests to the levels needed to control CWD. Therefore, in addition to liberal hunting seasons within this zone, the DNR is issuing permits to landowners to remove deer outside of the scheduled hunting seasons. DNR staff and staff from other cooperating agencies have supplemented landowner removal efforts by shooting deer on lands for landowners that have authorized access to their land.

Depopulation Program.

Below is an assessment of the depopulation program and other alternatives considered. The second half of this section is an assessment of the tools proposed to accomplish the depopulation as well as the alternative tools considered.

Proposed Actions.

Because there is no treatment for infected animals and no vaccine, depopulation as discussed earlier is currently the best available strategy for managing CWD in Wisconsin's deer herd. This would be accomplished using a combination of liberal hunting seasons, permits issued to landowners, and shooting deer by agency personnel. The effects of the specific methods are discussed later in this section.

To accomplish depopulation, different CWD management zones are proposed. The deer population objective for an affected area is to lower the population as close to zero as possible. An eradication zone (EZ), for the purpose of the proposed rule, is defined as those one square mile sections of land contained within or intersected by a 4½ mile radius drawn from the center of a section of land found to have contained an animal that tested positive for CWD. The biological basis for the 4½ mile radius is an attempt to balance the dispersal likelihood of potentially infected deer against the logistical difficulty of depopulating deer over a large area.

Simulation modeling (John Cary, Univ. of Wisconsin, pers comm.) and review of current literature on white-tailed deer life history and CWD dynamics suggest that CWD is most likely to spread across the landscape through the movements of infected live deer. A common, and likely the largest, movement is the dispersal of yearling bucks. In late spring or summer, yearling bucks leave their natal home ranges and disperse to new home ranges that are normally spatially distinct from their natal ranges and often can be some distance away (Nelson 1993). In the Midwest, these dispersal distances can be as long as 130 miles (Kernohan *et al.* 1994), although analysis of dispersal distance distributions (Nelson 1993) suggests that long-distance movements (greater than 30 miles) are quite rare, and that median dispersal distances are more likely in the 5-10 mile range (Nelson 1993). Mean distances from deer movement studies in southern

Wisconsin (O'Brien 1976) were 3.1 miles, although the samples from this study were small and it is not clear whether or not dispersal was being measured. Thus, defining an EZ required a judgment about the importance of rare but long distance movements to designate a meaningful distance from which to infer possible disease spread from known CWD detections. It also required balancing the use of large areas to encompass as much likely dispersal as possible with the practical difficulty of depopulating deer from large areas (Saunders and Bryant 1988, Choquenot *et al.* 1999, Van Deelen and Etter, in press).

New EZs may be established under the proposed rule. The special hunting seasons and landowner and DNR authorities discussed in this document may then be applied to the newly discovered affected areas to eradicate the disease.

An Intensive Harvest Zone (IHZ) would be established under this proposed rule. It would encompass an EZ but would be extended to roadways easily recognized by hunters. The population goal of an IHZ is to reduce the deer herd as low as possible (less than 10 deer per square mile) to prevent transmission of the disease outside the EZ. The proposed density goal of 10 deer per square mile of deer habitat (approximately four deer per square mile land area) is comparable to the deer density in the CWD endemic area of Colorado (approximately five to six deer per square mile of land area; Vieira 2001, Vieira and George 2001). The purpose of an IHZ is to define a boundary that is identifiable to hunters, so that special regulations and more liberal hunting seasons can be attributed to this zone in order to achieve the maximum possible reduction of the deer population. In this rule an IHZ would be established around the current affected area in southwestern Wisconsin. This IHZ extends beyond the boundaries of the current EZ to identifiable road boundaries. New IHZs may be established by additional rule orders.

Currently there is one EZ and adjoining IHZ in southwestern Wisconsin. As of January 22, 2003, this EZ is 411 mi^2 but could expand if any positive samples for CWD are found at the edge of the current EZ based on the criteria above. Increased surveillance should detect if CWD occurs elsewhere in the state.

Effects.

Deer population. The obvious effect of depopulation on the deer herd within an EZ and IHZ would be a greatly reduced number of deer. During the first year of the depopulation program, the deer herd would be reduced, and in subsequent years, the herd may be lowered close to zero. In addition to fewer deer on the landscape, it is anticipated that the behavior of deer would change becoming much more secretive as well as becoming more active at night during prolonged hunting seasons.

The rapid population reduction planned for an EZ and IHZ zone would require changes to deer herd monitoring procedures because the traditional sex-age-kill method is dependent on fairly stable hunting season frameworks and harvest rates. Deer populations in an EZ and IHZ would be monitored using helicopter or fixed-wing aerial surveys.

Disease control. Assuming that diseased areas are located and designated as EZs, depopulation of the deer in these zones would facilitate disease control by: 1) removing infectious animals; 2) reduce the density of deer to near zero; and 3) reducing the accumulation of CWD prions (either shed by infectious deer or leached from the carcasses of infected deer) in the environment. Even though depopulation to control CWD must be considered experimental, there appears to be no practical alternative (Williams *et al.* 2002a).

It is difficult to predict how successful Wisconsin's management program would be in its goal of eradicating CWD from the state. The success of the proposed disease control program would depend on a number of factors including the current geographic distribution of CWD, landowner willingness to allow hunters and agency shooters access to their land, hunter willingness to hunt in the affected area and shoot more deer than they normally would, and available agency resources for CWD control. Simulation modeling using a large-scale, spatially-explicit, individual-based model of CWD dynamics suggest that disease eradication may be achieved given high levels of surveillance testing and high levels of landowner and hunter participation with deer removal (John Cary, University of Wisconsin, pers. comm.). However, if CWD is already substantially more widespread than the currently known area near Mount Horeb, then eliminating CWD from Wisconsin may be extremely difficult. If a substantial number of landowners in the affected area do not allow access to their land, and if hunters are not willing to shoot additional deer in the affected area,

then eliminating CWD would be extremely difficult. Close cooperation would be needed between the DNR, landowners, and hunters to avoid creating refuges for CWD-infected deer and assure the successful elimination of this disease.

Because of the size of the deer population in the current EZ (estimated to be 25,000 in fall 2002), it is expected that depopulation would involve a multi-year effort. Model simulations that resulted in successful disease eradication required 5-6 years or longer (John Cary, University of Wisconsin, pers. comm.). It would be critically important to closely monitor the progress of the management program during this period to maintain public support for the program and to be able to assess effectiveness of management strategies and to make timely adjustments if needed. Although the depopulation effort is expected to require several years to complete, it is important to initiate it promptly to improve the likelihood of success. Delays in starting the depopulation would likely allow for greater transmission, increasing the number of infected individuals, the geographic distribution of infection, and the level of potential environmental contamination. Failing to act rapidly could result in CWD becoming endemic in southwestern Wisconsin, precluding the possibility of CWD eradication.

Ecological effects. The specific ecological effects of reduced deer population size in an EZ would vary depending on the location of the zone. Currently, the EZ defined by the 2002 emergency rule covers a 411 square mile area in southwestern Wisconsin. If CWD is confined to southwestern Wisconsin, the ecological effects of deer depopulation would be more limited than if a much larger EZ is defined in response to the discovery of CWD in other regions of the state.

Few studies have directly measured deer density and its effects on the entire ecosystem. Short and long-term ecosystem effects are situation-specific, but documented negative effects of deer on ecosystems are virtually always a function of overabundance (reviews in VanderZouwen and Warnke 1995, Waller and Alverson 1997, McShea *et al.* 1997). The recent Environmental Assessment done to evaluate effects of altering deer management unit boundaries and population goals (VanderZouwen and Warnke 1995) contains an exhaustive review of the scientific literature on deer density effects on ecosystems at that time. The following paragraphs are summaries of that effort for discrete ecosystem components. Literature citations are not repeated here but can be found in the Environmental Assessment, which can be obtained by contacting the DNR through their website at http://*www.dnr.state.wi.us*.

Herbaceous Vegetation. Reducing the deer herd to zero could have an effect on herbaceous plants. Deer eat a wide variety of herbaceous plants during the growing season (species from 70 genera and/or families in the north and 53 in the south). Characteristics of herbaceous plant species that could benefit by very low deer populations include rare species, species found in restricted habitats, short-lived species, species that produce only single stems, and species highly preferred by deer. Species that are common and well distributed are unlikely to be greatly affected unless they are highly selected by deer. Prairie forbs selected by deer tend to have a relatively low abundance compared to the other more abundant prairie species; therefore, lower deer populations could have a significant benefit on the reproductive output of these species. Forest species that could benefit are bluebead lily and Canada mayflower. In southern fragmented woodlands, large-leaved trillium could benefit at deer densities less than 15 deer per square mile. The literature provides few deer density estimates when impacts become significant for a given species. Although there are few data to base judgments on what deer densities affect herbaceous vegetation, deer densities at low levels may likely benefit some rare species, some forbs in native prairies, some spring ephemeral in southern woodlands, and some forest floor species in the north, especially those found in restricted habitats.

Woody Vegetation. Since deer browse woody vegetation during winter, regeneration, abundance, and vigor of trees and shrubs could benefit from reduced deer numbers. Information is inadequate to scientifically determine the overall impacts of deer densities on the vegetation in the state. There have been studies documenting extreme high levels of deer herbivory but few carefully designed studies assessing the effects of different deer densities on vegetation. Generally, the published literature reports moderately heavy browse impacts occur to the most preferred trees and shrubs at deer densities of 20 per square mile. Heavy impacts were noted in many states at greater than 25 deer per square mile. These studies were conducted in regions of the country where forests have higher productivity (carrying capacity) than Wisconsin. Based on these studies and productivity of Wisconsin forests, moderately heavy browse impacts could occur at 15-20 deer per square mile and heavy browse impacts could occur at more than 20

deer per square mile in Wisconsin. These preferred tree and shrub species could benefit from lower deer numbers. Impacts by deer on woody vegetation in northern Wisconsin during winter can be significant if deer are concentrated within an area for thermal cover and mobility during times of deep snow. Preferred conifers sensitive to browsing (*e.g.,* white cedar, hemlock, Canada yew, and white pine under some conditions) may benefit at low deer densities in these local wintering areas. The overall extent of this impact is unknown and would depend on how much and how often deer are concentrated. At low deer densities in the north, preferred deciduous trees sensitive to browsing (*e.g.,* yellow birch, basswood, oaks, and white ash) and shrubs may also benefit. Oak species and other preferred shrub species in the southern regions might benefit from low deer population densities. Deer impact on conifers in summer is negligible since they seldom use them in that season. Impacts on deciduous trees and shrubs by browsing leaves and new shoots can be substantial. Lower deer levels concentrating in the northern region around a summer food source (*e.g.*, regenerating clearcut or forest opening) could benefit preferred deciduous species that are sensitive to browsing (yellow birch, basswood, and white ash). In southern regions, lower deer densities could benefit preferred species such as the oaks, basswood, and white ash.

Invertebrates. Some species could benefit from lower deer densities by indirect effects on vegetation. There are no data suggesting how invertebrates are affected by different deer densities. Inference from knowledge about invertebrates would suggest that the increase of a plant species that supports a host-specific invertebrate population, due to reduced deer browsing, would cause that invertebrate population to increase. Some invertebrates would benefit more than others because of reduced deer herbivory. Invertebrates requiring a single plant species to complete its life cycle would likely benefit from lower deer numbers. Invertebrate species that use only the flowering part of one plant to complete its life cycle that is highly preferred by deer would benefit even more from lower deer numbers. A detailed analysis of the impacts of deer browsing on invertebrates and host-specific plants needed to complete their life cycle is needed to understand the effects of deer herbivory on invertebrates. It is possible that a reduced deer herd could result in fewer deer ticks and a possible reduction in cases of Lyme disease and *Erhlichiosis*.

Herptiles (reptiles and amphibians). Reduced deer numbers could indirectly benefit or harm herptile species. There are no data on deer effects on herptiles. Indirect effects by deer changing habitats are the only way to assess deer impacts on herptiles at this time. Deer could modify the habitat structure needed by specific herptiles or change the food base (invertebrates) for herptile species. Thirty-eight herptiles (14 rare) occur in the same habitats as deer and could potentially be affected by deer herbivory. Although no data exists for analysis, the following suggestions are inferred from what is known about herptiles and their habitats. All of the state's insectivorous herptiles are believed to be generalists, and it is unlikely deer are causing a general decline in invertebrate biomass and reducing the food base for herptiles. It is more likely that deer could alter habitats and indirectly affect herptiles. Of the 14 rare herptile species, five need open habitats (*i.e.* wood turtle, Blanding's turtle, ornate box turtle, western worm snake, and prairie ringneck snake) and are suffering from advancing woody plant species succession. Reduced deer densities and browsing might harm these herptile species by reducing more open habitat. Four herptile species need moderate levels of brush and open habitats (western slender glass lizard, bull snake, eastern massasauga rattlesnake, and timber rattlesnake). These species could be positively or negatively affected depending on the intensity of browsing. The remaining five rare herptiles would be unaffected by deer density (four-toed salamander, northern ringneck snake, black rat snake, Butller's garter snake, and the western ribbon snake). The density of deer needed to bring about these habitat changes is unknown.

Small mammals. No direct relationship between deer and small mammals was found. Deer, however, may impact small mammals by altering their habitat (*e.g.*, litter layer) and food base (*e.g.*, seeds) by changing plant composition. Reduced deer densities could therefore benefit or harm certain small mammal species depending on the species' habitat needs.

Birds. Bird species could indirectly benefit or be harmed by changes in vegetation caused by deer foraging. Three studies discuss impacts of differing deer densities on birds in the eastern United States. Ground and canopy nesting birds do not seem to be greatly affected by deer browsing. Shrub nesting species were most impacted by deer browsing if the shrub layer is reduced. Bird species least likely to be affected by deer browsing in are ground or canopy nesting species. However, long-term impacts on forest species composition by deer browsing (shift toward conifers in canopy) could benefit canopy-nesting birds preferring conifers (*e.g.*, hemlock and white cedar) in northern Wisconsin. Deer densities in northern Wisconsin are close to the level where negative impacts on shrub nesting birds were documented in other

states. It is unclear where significant impacts of deer browsing on birds begin, but it is believed to be between 15-30 deer per square mile. When deer densities reached 35 deer per square mile there were documented negative impacts on some bird species in the eastern U.S. These studies were conducted in regions of the country where forests have higher productivity (carrying capacity) than Wisconsin. For forests in Wisconsin, lower deer densities than those reported above could affect bird species. In the northern region, species like black-throated blue warblers, Canada warblers, and Swainson's thrush would likely benefit from lower deer densities. If the developing canopy does include conifers, then species like blackburnian warbler, golden-crowned kinglet, and northern parula may benefit in the future. Some deer densities in the south are at or very close to the deer densities that significantly impacted birds in eastern studies. Species that may benefit most from lower deer densities in southern Wisconsin are chestnut-sided warblers, worm eating warblers, mourning warbler, Kentucky warbler, and hooded warbler. The wood thrush might also benefit because it nests primarily in shrubs or saplings in Wisconsin. Other species that might be affected by less deer browsing in southern Wisconsin are the veery and white-eyed, Bell's, and red-eyed vireos. It is not expected that lower deer densities would have a significant impact on turkey densities.

Moose and Elk. Both populations of moose and elk are extremely small in Wisconsin at this point in time. Interspecific competition between elk, moose, and deer does not seem likely except in severe winters when both elk and deer may occupy conifer yards. Due to the extremely small populations of moose and elk in Wisconsin, competition among these three species seems insignificant. Deer act as a reservoir for the parasite *Parelaphostrongylus tenuis*. Mortality does occur from *P. tenuis* in elk but at levels too low to affect robust elk populations. Moose are extremely susceptible to *P. tenuis* and are not likely to persist if deer populations are above 15 per square mile; however, 90% of low deer density habitat surveyed in Wisconsin was judged as not suitable for moose. Moose and elk are likely to benefit from reduced deer density in northern Wisconsin.

Wisconsin has one wild elk herd that is located near Clam Lake in the northwestern part of the state. This herd was established in 1995 when 25 animals were transplanted from Michigan. The population has grown to an estimated 120 animals during the past seven years. The Natural Resources Board (NRB) has approved establishment of a second wild elk herd in Jackson County. This project is currently on hold to await completion of CWD surveillance within the central forest region. In addition, the NRB gave their approval contingent that elk be added to the wildlife damage program, which is dependent upon DNR promulgation of rules to establish an elk hunting season. The Jackson County introduction would need to meet all applicable regulations regarding the importation of cervids into Wisconsin, as well as all health testing and monitoring requirements.

Because elk are susceptible to CWD, the presence of CWD in Wisconsin poses a threat to their restoration in the state. Both the existing Clam Lake elk population and the proposed Jackson County population are outside of the CWD eradication and management zones. Failure to control CWD in the current EZ, however, could result in its spread throughout Wisconsin's deer herd, which would threaten the proposed Jackson County elk population and eventually could threaten the Clam Lake herd.

Large Carnivores or Scavengers. The gray wolf is the only large carnivore species that depends heavily on deer as a food source in Wisconsin. The Wisconsin DNR reclassified wolves from endangered to threatened in 1999, and the U. S. Fish and Wildlife Service started the process to reclassify them in 2000, and should complete the process in 2003. Deer are the primary food source for wolves in Wisconsin. Currently, the CWD management zones are in Wolf Management Zone 4. This zone includes 28 counties in southern and eastern Wisconsin that appear to have limited potential for wolves. Currently, no wolf packs are known to occur in this zone and no wolf depredations have occurred in the zone (Wydeven and Wiedenhoeft 2002). During July 2001-June 2002 wolf observations were reported from seven counties in the zone but these may include misidentifications. An adult male wolf was killed by a vehicle on the west-side of Madison in April 2002; however the presence of this wolf is not likely indicative of a resident population. Because the areas currently included in the CWD EZs and IHZs are outside of the northern and central forest wolf range, the proposed deer population reductions are not expected to have an impact on the recovery of Wisconsin's wolf population. If new EZs were established in the northern wolf range, it is unlikely that deer depopulation would have population-level effects on wolves given the unprecedented high deer populations in northern Wisconsin (Wisconsin DNR 2001) unless CWD was found to be widely distributed in the north.

Several other carnivore and omnivore species - black bear, coyote, and bobcat - prey on deer fawns when available. In addition, several species of birds use road-killed deer as a source of carrion - common raven, American crow, turkey vulture, and the bald eagle - are among these. These predator/carrion species are generalists and would not be expected to be greatly affected by changing deer densities.

Ecological Function and Productivity. Deer may have indirect impacts on other taxa within the ecosystem (*e.g.*, birds, small mammals, herptiles, invertebrates, etc.) or on ecological function or productivity due to their effect on vegetation. Direct impacts to ecological function and productivity by deer seems unlikely because vertebrates contribute very little directly to nutrient cycling and energy flux. However, deer browsing might alter the composition and structure of vegetation used by species in other taxa as habitat. Negative effects on native ecosystems associated with too few white-tailed deer have not been described or demonstrated in the scientific literature.

The depopulation proposed for a CWD EZ and IHZ would likely reduce many of the adverse ecological impacts that high deer densities in Wisconsin may have caused during recent years. If a large proportion of hunters decide not to hunt in the future because of human health concerns, deer harvests in the region may actually decline resulting in further growth of the deer population and subsequent greater adverse impacts on regional plant communities and dependent animal species. Eventually, an infected population would collapse from CWD and impacts from deer on the ecosystem would be lessened.

Carcass Disposal. Although the proposed rule does not establish specific methods for deer carcass disposal, depopulation of the deer herd in EZs and IHZs would likely result in additional unwanted deer carcasses requiring disposal. EZ and IHZ hunters may not want deer for fear of human health concerns or they may have more meat than they can use.

Questions have been raised regarding the safty of disposing potentially contaminated deer carcasses in landfills. Specifically, landfills are dependent upon wastewater treatment plants accepting the landfill's leachate (contaminated liquids collected at the base of the landfill). Treatment plants are in turn dependent on farmers accepting the sludge or bio-solids from the treatment plant for use as a fertilizer on their fields. The question was raised whether the prion could conceivably travel with the leachate to the leachate collection system, go through the wastewater treatment process and be spread on fields with the bio-solids.

The DNR, in conjunction with representatives of the Wisconsin Department of Health and Family Services, the Wisconsin Veterinary Diagnostic Lab, and the Department of Agriculture, Trade and Consumer Protection, reviewed the available information and concluded that landfills provided reasonable containment of the prion. A detailed risk assessment was prepared. The risk assessment concluded "that landfilling of CWD-infected deer does not pose a significant risk to human health" and "the risk of spreading CWD among Wisconsin's deer population by landfill disposal of infected carcasses is quite small."

Although technical staff for both landfills and wastewater treatment plants generally agreed with the DNR's conclusion on the safety of landfilling the deer, there remained a fear of the public perception that landfilling presented a risk to both human health and the spread of the disease to other deer. Treatment plant operators were fearful that farmers would not accept their bio-solids, leaving them with a disposal problem. Landfill operators in turn were fearful that the treatment plants would no longer accept their leachate, leaving them with the choice of closing down or establishing their own treatment systems at an extremely high cost. Based on this fear, landfill operators were unwilling to accept deer carcasses from the 2002 summer hunts. Based on experience gained in 2002, CWD management of carcasses was designed to address both the actual risks associated with disposal of CWD-positive tissues and additional perceived risks on the part of stakeholders.

In 2002, disposal containers were provided at each deer registration station in the current EZ. All deer harvested in the EZ were tested for CWD and carcasses were placed in cold storage until their test results were available. Carcasses that tested negative were disposed in engineered landfills while those that tested positive were incinerated. See Appendix C for a discussion of the alternative disposal methods.

Socio-economic Effects.

The deer depopulation proposed for the CWD EZ and IHZ would likely result in short-term loss of hunting recreation, hunting associated industries, and wildlife viewing opportunities. At the same time, the deer population reductions may be expected to result in less damage to agricultural crops and timber resources and fewer deer-vehicle accidents. These impacts would be expected to last for the duration of disease control efforts (currently estimated at five years) and subsequent repopulation of the area.

The Wisconsin Chippewa tribes are entitled to harvest up to 50% of deer available for harvest in deer management units that fall within the ceded territories. None of the ceded territory falls in the southern portion of the state where the current eradication and herd reduction zones are located. Tribal deer harvest occurs primarily in the northern deer management units, while limited harvest occurs in all other portions of the state except the south. If CWD is discovered in the ceded territories, depopulation of the deer herd could have an impact on the Chippewa tribes and the overall tribal deer harvest, depending on the extent and location of the disease. The depopulation of the deer herd may impact tribal customs, venison availability, and recreational opportunities.

Deer and deer hunting are integral parts of Wisconsin's socio-economic fabric. On opening day of the traditional 9-day gun deer season, nearly 700,000 hunters pursue white-tailed deer. During the past decade, hunters have harvested an average of more than 400,000 deer a year. An estimated seven million hunter-days of recreation are provided annually during the archery and gun hunting seasons. Economically, deer hunting supports thousands of jobs in Wisconsin and it is estimated that it contributes close to $1 billion to the state's economy (IAFWA 2001). It is anticipated that the increased hunting opportunities in an IHZ would result in an intial period of increased hunter participation, followed by a decline in hunter numbers and effort as the deer population decreases. Hunter numbers and hunting opportunities would be expected to be low for the duration of the disease control effort and increase with subsequent repopulation of the area by deer. In additon to hunting, an estimated 2.4 million people participated in wildlife watching actvities in 2001 contributing approximately $1.3 billion to Wisconsin's economy (IAFWA 2001).

Changes in property values are another possible effect of deer depopulation in an EZ. Whether this would be an effect or whether the effect would be a positive or negative change in a property's value may be largely dependent on the type of land, landuse, and the motivation of the parties involved. The magnitude of any effect would likely depend on the extent and location of an EZ and the types of property involved (*e.g.* recreational, agricultural or rural/urban).

High deer densities can result in significant damage to agricultural crops. An additional benefit of depopulation of deer would likely be an elimination of agricultural deer damage in an EZ for the period of time that the deer population is near zero. For instance, in the current EZ, deer densities may be as high as 75 deer per square mile. Deer crop losses in this 411-square mile zone would be reduced to near zero. The extent of this benefit would depend on the extent and location of an EZ in relation to the types of crops and the amount of agriculture in the area. As an EZ is repopulated deer agricultural damage would likely increase. Appendix G presents a discussion of current deer crop damage.

High deer densities may result in damage to the forest products industry. High deer densities are a concern of county foresters and industrial forest landowners, especially when deer populations exceeded 20-25 deer per square mile of habitat (Zastrow 1995). An additional benefit of depopulation of deer would likely be an elimination of forest deer damage in an EZ for the period of time that the deer population is near zero. The extent of this benefit would depend on the extent and location of an EZ in relation to the forest types and the acreage of forests in the area. As an EZ is repopulated deer damage to forests would likely increase. Appendix H presents a discussion of the economic impacts of deer on forests.

Deer-vehicle accidents are a significant problem in Wisconsin. The number of accidents are related to both the number of miles driven by motorists and the number of deer. In some counties, deer collisions are one of the most prevalent causes of vehicle accidents, accounting for up 64% of all vehicle accidents (average of 16%). Deer collisions account for over 30% of vehicle crashes in twenty counties. In 2001, there were 801 people injured and nine killed in deer-vehicle collisions. It has been estimated that there were over 40,000 deer-vehicle collisions each of the last several years in Wisconsin. Annual vehicle repair costs total

approximately $100 million. Appendix I presents a discussion of deer-vehicle accidents. An additional benefit of depopulation of deer would likely be an elimination of deer-vehicle collisions in an EZ for the period of time that the deer population is near zero. The extent of this benefit would depend on the extent and location of an EZ in relation to the miles of major roads and the human population in the area. As an EZ is repopulated deer-vehicle collisions would likely increase.

Currently there is no evidence that CWD can be transmitted to humans or livestock (see Susceptibility in the Background section:). No cases of human prion disease have been associated with CWD (Williams *et al.* 2002a). In 2002, a report surfaced regarding three patients from northwest Wisconsin who died of neural disorders and who reportedly consumed venison. Upon investigation of this report by the Centers for Disease Control, no association with CWD was found (DHFS 2002). However, because CWD is a TSE and the transmission of BSE to people in England, there remains concern about the perceived risk of CWD transmission to humans and cattle. The deer depopulation planned for an EZ is believed to be the most effective strategy for eliminating CWD from the state and minimizing any potential risk for humans and livestock.

The tradition of hunting, which is one of the cornerstones of the state's outdoor recreational heritage, would also be effected by deer depopulation. For over a century, deer hunting has taken place in the northern and central Wisconsin, and since the mid-1900's, in southern Wisconsin. The effect of depopulation on this fall activity is difficult to measure, but the removal of a tradition that is so deeply ingrained in a human culture cannot be overlooked. On opening day of the traditional 9-day gun deer season, over 700,000 hunters pursue white-tailed deer. For these hunters hunting is an opportunity for camaraderie, recreation, food, and to take part in a tradition handed down from one generation to another. However, depopulation creates problems for these hunters. First, these hunters are now being asked to assist with the elimination of the animal that is the source of their tradition. Secondly, hunters are being asked to harvest more deer than they can use. Depopulation, while crucial for eradication of the disease, remains a personal dilemma for hunters and resource managers.

Analysis of Alternatives to Depopulation.

No Action. Under the "no action" alternative there would be no effort to reduce the deer population in either an EZ or IHZ below the currently established population goals. Hunting season frameworks would not change.

Disease Control. Based on the information known at this time, current science and the experiences of other states, no intervention would likely result in increased prevalence and geographic spread of the disease. For example, research in Colorado provides preliminary evidence of decreased adult survival in areas where CWD is established and of increasing prevalence in endemic areas over time. These findings support model predictions that the disease would increase in frequency of occurrence and would significantly impact deer populations in Wisconsin.

At present, the best available evidence from Colorado and Wyoming indicates that in the absence of management intervention, CWD would likely increase in prevalence and distribution among susceptible cervids. There is evidence that CWD is expanding its geographic range within North America and that humans have facilitated this process. Also, wild cervids live in a highly manipulated environment in which some natural processes may not operate. The significance of the disease as a factor driving cervid population dynamics is unclear. Regardless of these factors, the disease is of significance because of public concerns about TSEs in general and perceived risks to humans and domestic animals. It is difficult to determine circumstances under which CWD might "burn itself out", because there are no documented instances in which the disease was introduced but failed to establish and maintain itself. There is no evidence at present of genetic resistance to CWD within mule and white-tailed deer, although this has not been studied extensively. If it exists, genetic resistance might spare individuals in wild populations, but it is unclear that it would have a significant protective value at the population level, at least in the short-term.

The potential advantages of genetic resistance may be limited by the chronic nature of the disease, generally low prevalence in deer populations, and high productivity of white-tailed deer. Animals that die of CWD are adults, and most have reproduced one or more times prior to death. Thus, because of the age structure of these populations, susceptible genes would be passed to future generations before the

animals could become clinically ill and die from CWD. This situation in wild cervids stands in contrast to scrapie in domestic sheep, where farmers have the option to manipulate the genetic structure of the herd by removing both the infected adults and their offspring.

Because of the many scientific uncertainties regarding the basic biology and ecology of CWD, management must be considered experimental. This cannot, however, be taken as an argument for waiting for new research or for doing nothing. Because CWD behaves in a manner similar to other infectious diseases, it is reasonable to expect that management techniques used for chronic, late-onset infectious diseases might be appropriate, in the absence of direct information. Evidence from endemic areas of Colorado and Wyoming indicates that the result of no intervention is increased prevalence and distribution of the disease.

There is no known antibody response to the CWD agent. There is some evidence of host response to TSE infections. Glial activation occurs in the brain with many TSEs (Hadlow 1996), and an acute phase response has been observed in mice experimentally infected with scrapie (Coe *et al.* 2001, Williams *et al.* 2002a) Animals that develop clinical symptoms invariably die (Williams *et al.* 2002a).

A specific genotype (PNRP) plays a major role in development of natural and experimental scrapie in sheep and mice (Hunter *et al.* 1992, Bruce *et al.* 1994, O'Rourke *et al.* 1997). It is not yet known if particular genotypes confer resistance or increase susceptibility to CWD. A specific amino acid (Codon 132 methionine) was over-represented among free-ranging and captive CWD-affected elk when compared to unaffected elk (O'Rourke *et al.* 1999), suggesting potential for differential susceptibility. Resistance associated with PNRP genotype has not been recognized in deer, but is being investigated. Prion gene sequence analysis of CWD-positive and CWD-negative deer from Wisconsin's current EZ suggests that at least 88-98% of the deer in this region would be genetically susceptible to CWD (Johnson *et al.* in prep.). Since no resistance is known in deer for CWD, there is no reason to expect CWD will not greatly impact the deer herd.

Gross and Miller (2001) developed a computer simulation model of the dynamics of CWD in mule deer populations. The model projected disease dynamics, changes in deer population size, and effects of control strategies. The simulated changes in CWD prevalence were sensitive to estimates of transmission rates. If transmission rates were low CWD was not sustained in projected populations; however, using realistic estimates of transmission rates resulted in population extinction. Simulated infections reduced adult survival and population size relative to uninfected populations. Once prevalence increased to about 2%, the proportion of infectious individuals in the population increased and populations consistently declined. Their model forecasted two to four-fold increases in CWD prevalence during a 20-30 year time frame. The majority of simulated populations collapsed to extinction in 60-100 years. John Cary at the University of Wisconsin developed a large-scale, spatially-explicit, individual-based model of CWD dynamics that was an extension of the Gross and Miller (2001) model (Cary 2002). This model simulates the spread of CWD across landscapes for white-tailed deer. Model simulations suggest that, without management intervention, CWD prevalence may increase rapidly over the next 10-15 years resulting in a substantial decline of local deer populations. The model further suggests that, without active management, the area affected with CWD could increase more than 10-fold to over 5,000 square miles during the next decade.

If contamination of the environment from saliva, urine, feces, or carcasses is an important factor in the transmission of CWD, then the increase in the number of infected deer under this alternative could substantially increase the transmission rate among deer. Under the no action alternative, contamination of the environment would likely occur, resulting in a greater rate of increase in prevalence, more rapid spread of CWD, and more rapid population collapse.

Ecological and Socio-economic Effects. Under the no action alternative, deer populations throughout southwestern Wisconsin would be managed for the current population goals. Current deer population goals represent an attempt to balance public demands for the positive benefits of deer (consumptive and non-consumptive) with the public's willingness to accept the economic and ecological effects of deer. Maintaining deer populations at the established goals during the next few years can be expected to meet the public's demand for deer hunting, recreation, and wildlife viewing opportunities and tribal harvest

allocations, but would maintain current levels of negative impact on plant and animal communities, deer damage to agricultural crops, and high numbers of deer-vehicle accidents.

It is difficult to predict the long-term consequences of failing to contain and control CWD in Wisconsin given current knowledge of this disease. However, it would likely have serious long-term ecological and socio-economic consequences. Initially, public concerns about the safety of venison consumption may reduce hunter pressure and harvests in the CWD affected area resulting in substantial growth of the local deer population. The resulting browsing pressure may adversely impact the local natural plant community and animal species that are dependent on native plants. Higher deer populations could also increase the rate of CWD transmission making it more difficult to control the disease. Failure to control CWD could eventually lead to the collapse of the local deer population and the spread of the disease to other regions within Wisconsin and surrounding states. This eventual collapse of the deer herd would likely result in ecological and socio-economic effects similar to those experienced under the proposed action. High levels of environmental contamination could preclude the repopulation of deer in the affected areas. Widespread declines in the deer population would have major impact on deer hunters and wildlife watchers along with wildlife dependent businesses. The spread of CWD throughout Wisconsin's wild deer population could increase the potential risk to farmed cervids and potentially the risk of transmission to cattle and humans.

Spread of CWD throughout the state could place Wisconsin's newly restored elk population at risk. A potential decline of the Central and Northern Forest deer populations could adversely impact gray wolves.

If CWD is discovered in the ceded territories and the deer herd collapses, with little possibility for repopulation, there would be long-term impacts on the Chippewa tribes and the overall tribal deer harvest. The deer herd collapse would impact tribal customs, venison availability, and recreational opportunities.

Deer Population Reduction and Research. Under this alternative an effort would be made to reduce the high deer population in the current CWD affected area through the use of hunting to a goal of 10 deer per square mile. Hunting season frameworks would be altered to facilitate this population reduction but out-of-season shooting permits would not be issued to landowners and agency sharpshooters would likely not participate in removal activities. Hunter harvested deer would be sampled and tested for CWD to determine the distribution of the disease and research on disease transmission would be conducted.

Disease Control. The reduction in deer population density in the affected area, together with the ban on baiting and feeding of deer, may slow the rate of increase in prevalence of CWD and the rate of spread. However, these actions alone likely would not reduce prevalence or lead to the elimination of CWD from the state. Rather, this alternative would likely lead to a slowly increasing prevalence and continued spread of CWD. Depending on how long it takes before research results are available, prevalence and geographic spread could reach a point where it may no longer be possible to control or eliminate the disease. Moreover, experience with quota setting in the affected DMUs, recent experience with CWD-related removal effort (Wisconsin DNR unpubl. data), and efficiency studies of Midwestern deer hunters (Van Deelen and Etter, in press) indicate that achieving a goal density of 10 deer per square mile is unlikely without the use of out-of-season permits, special landowner permits, or professional sharpshooters.

Field data from Colorado and Wyoming demonstrate that CWD can persist, increase in prevalence, and spread to new areas in mule and white-tailed deer populations that occur at densities that are much lower (approximately five to six deer per square mile) than those in southwestern Wisconsin (Miller *et al.* 2000, Vieira 2001, Vieira and George 2001). Miller *et al.* (2000) suggests that prevalence of CWD in deer at densities of 5-6 deer per square mile in Colorado and Wyoming may have increased 0.5 to 0.7% annually during the 1980s and 1990s. If deer populations were reduced to 10 deer per square mile of deer habitat in the EZ, it would equate to 5-6 deer per square mile of total land area as measured in Colorado. Colorado field data suggests that at 10 deer per square mile habitat in the EZ, CWD prevalence would likely increase and CWD may spread to new areas. Because infected deer would remain in the affected area under this alternative, the level of environmental contamination could also increase.

An epidemiological model of the dynamics of CWD in mule deer populations was developed by Gross and Miller (2001). Gross and Miller (2001) report that as CWD prevalence increases, the time and effort required to eliminate the disease from an infected population also increases. Prevalence of CWD may reach a point where it may be difficult or impossible to control or eradicate the disease.

Experience from other states, CWD management plans from Colorado and Wyoming, the multi-state CWD Management Plan, and the National CWD Management Plan all recommend that depopulation may be the best alternative to eradicate the disease from areas with new outbreaks of CWD before it becomes endemic.

Currently, CWD prevalence in the EZ and IHZ is estimated to be 2.1%. Statistically reliable research results from wildlife populations typically takes two to three years or longer because of the annual variability due to weather and other factors. Current technology does not allow quick detection of the presence of the CWD. Therefore, research on transmission routes and rates can takes up to 15 months or more before even knowing if the disease has been transmitted. Waiting until research results become available before intervening could allow CWD prevalence to increase to the point where it will be extremely difficult, if not impossible, to control and eradicate the disease from the infected population.

Rather than reduce deer density and wait for research results to become available, a safer approach which will keep more options open for future management when research findings do become available, may be to depopulate the deer herd eliminating as many of the infected deer as possible now. When new research results become available, CWD management can then be altered to be consistent with the best science and strategies for controlling and eradicating the disease available at that time.

Ecological and Socio-economic Effects. This alternative may slow the rate of increase in CWD prevalence and the rate of spread, but likely would not reduce its prevalence or prevent CWD from spreading. Therefore, the ecological and socio-economic consequences would likely be similar to the no action alternative but may be delayed.

Live Trap, Test and Euthanize Diseased Animals. This alternative would involve live trapping deer in the affected area, testing them to determine if they are infected with CWD, and euthanizing any positive individuals. This alternative would require the existence of a reliable and practical CWD test for live animals and extensive time and effort devoted to trapping and sampling live deer.

Disease Control. Test-and-euthanize programs are only appropriate for disease situations where: 1) the entire population can be examined, 2) infected individuals can be identified, 3) infected individuals can be readily captured, 4) individuals known to be free of the disease can be isolated from the untested portion of the population, and 5) removal of a portion of the population is acceptable (Wobeser 2002). The primary limitation of this alternative is the need to capture, handle, and hold individual animals. The impracticability of capturing over 3,000 bison and the difficulty of holding test-negative animals so that they would not be exposed to infected individuals were major reasons that test-and-euthanize was rejected for elimination of brucellosis and tuberculosis from a free-ranging population of bison in Wood Buffalo National Park, Canada (Wobeser 1994).

Recent research has evaluated the use of IHC on biopsies of tonsillar tissue for mule deer (Wolfe 2002). Wolfe *et al.* (2002) report that CWD prevalence estimate from IHC testing of tonsillar biopsies of live-captured mule deer in two areas of Colorado were comparable to prevalence estimates from tonsillar tissues from hunter harvested deer. The biopsy procedure requires the capture of the animal, anesthesia, specialized equipment, and specific technique to obtain tissue samples that are usable for testing. The requirement for IHC testing precludes the use of the procedure for on-site testing (*i.e.* results of the test are not available for at least several days). Wolfe *et al.* (2002) suggested that tonsillar biopsy may be useful to conduct or augment surveillance testing in areas where harvest or removal may not be feasible (*e.g.*, urban or rural residential areas or National Parks).

Simulation modeling by Gross and Miller (2001) suggests that to be effective in eliminating CWD from a population of mule deer, a test and euthanize program would require the testing of a large proportion of the population (30-70%) over an extended period of time (10-50 years). These simulations further showed that the effectiveness of a test and euthanize program declines rapidly as prevalence increases. Wolfe *et al.* (2002) suggest that selective removal of test-positive individuals may help reduce the prevalence rate in endemic areas, but they acknowledge the practical limitations of this approach. Broad implementation of a

testing and euthanize approach is limited by the need to capture, anesthetize, precisely sample, and hold or radio-collar individual deer until test results are available. Tonsillar biopsies may be most useful as a tool for regulatory management of farmed cervids.

The DNR is planning to take tonsillar biopsies from deer captured for the deer ecology component of the CWD research program. Because these research animals will be radio-collared it will be possible to euthanize any individuals that test positive. However, numerous logistical constraints preclude the use of this alternative for controlling the current CWD outbreak. Foremost among these is the difficulty of capturing the 25,000 to 30,000 deer that are estimated to be within the current 411 mi^2 EZ and potentially exposed to CWD. Due to the stress of capture and handling, some deer may be injured or would die of capture related stress during the capture attempt and subsequent confinement. Because deer in early stages of infection may not have detectable levels of CWD prions and could test negative (false negatives), it would be necessary to hold test-negative deer and retest them over an extended period of time.

Ecological and Socio-economic Effects. Because this alternative would likely be ineffective in preventing the spread of CWD or reducing its prevalence in the affected area the ecological and socio-economic consequences are likely to be similar to the no action alternative. Economically, however, this alternative would be much more costly than the no action alternative due to the large amount of time and effort required to trap and test deer.

Selective Removal of Individual Animals. This alternative would involve the removal of selected individual animals without prior testing. Individual deer could be selected based on various criteria. Possible criteria include the appearance of clinical symptoms of CWD (see Pathobiology section) or an identifiable subset of the population that may have a higher prevalence or a greater potential to spread the disease (*e.g.*, dispersing yearling males).

Disease Control. Selective removal of individual animals exhibiting clinical symptoms of CWD has been practiced in the endemic areas of Colorado and Wyoming for a number of years but has not been successful in reducing prevalence in affected populations (Williams *et al.* 2002a). The effectiveness of this technique may be limited by the long period of time between when an animal is infected and when it begins to exhibit clinical symptoms (15 months or more), during which it may be able to infect other susceptible individuals. Furthermore, early stages of clinical CWD may be subtle and unrecognizable on casual observation (Williams *et al.* 2002a). The small number of clinical cases detected in portions of Colorado and Wyoming where prevalence rates were high illustrates the inefficiency of this approach for disease control (Miller *et al.* 2000).

Although targeted removal of clinical animals would likely be ineffective for control of CWD, it may be useful for detecting new CWD areas (Miller *et al.* 2000). The emergency rule adopted by the Natural Resources Board does allow the DNR to issue replacement permits to hunters who shoot a deer believed to be diseased. This provision is designed to encourage hunters to shoot potentially sick deer and submit them for testing. Encouraging hunters to shoot and surrender suspect animals is an important component of the DNR's statewide surveillance effort.

Currently little information is available about possible differences in prevalence among sex and age classes of white-tailed deer that might be used to design a selective removal program. This is one of the questions being addressed in the disease dynamics portion of Wisconsin CWD research program.

Ecological and Socio-economic Effects. Because this alternative would likely be ineffective in preventing the spread of CWD or reducing its prevalence in the affected area the ecological and socio-economic consequences are likely to be similar to the no action alternative.

Depopulation Program Tools

These proposed tools were developed following discussion with the public and many organizations at meetings across the state and following review of public input on alternatives presented in a questionnaire at meetings and on the Internet (Appendix D). Over 3,000 questionnaires were completed and returned. Focus groups were held with landowners and hunters from the current affected area to get additional public input. DNR recommendations followed this input with a few modifications based on experience with deer herd reduction regulations. Conflicts with other land uses were considered; however, control of CWD through herd reduction was given a higher priority than conflicts with other recreational uses. The following section provides an assessment of the proposed tools to accomplish depopulation as well as an assessment of alternative tools considered.

Proposed Actions.

A combination of tools would be necessary to achieve depopulation. No one tool is expected to achieve depopulation by itself.

Extended Season. The rule proposes that the hunting season in an EZ and IHZ begin on the Thursday before the last Friday in October, same as the Zone T season, and last through January 31. An IHZ archery season would start on the Saturday nearest September 15 and run through January 31.

Unlimited Tags. The rule proposes that hunters not be limited on the number of "earn-a-buck" tags they can acquire. By policy, the DNR has limited tag issuance to four per hunter per day. These tags can be used on antlerless deer in an EZ and IHZ and HRZ. They can also be used on bucks if an antlerless deer is shot and tagged first and the antlerless deer is transported along with the buck to the registration station. Tags issued with the archery and gun deer licenses and Zone T antlerless deer tags can be used in the same manner as the "earn-a-buck tags". Offering unlimited and free tags is expected to increase harvest of deer. Hunters have suggested that free tags would increase their willingness to harvest deer.

Earn-a-Buck Regulation. The rule proposes an earn-a-buck regulation (*i.e.* antlerless deer must be tagged by a hunter before that hunter can shoot a buck) in an IHZ. This rule applies to archery hunting, gun hunting, muzzleloader hunting, and hunting under authority of a landowner permit in the archery or gun seasons. Hunters can earn buck tags with antlerless deer killed in the archery season and gun deer season, as well as those killed under authority of an agricultural damage shooting permit or CWD landowner permit. There is no limit to the number of bucks that may be killed by a hunter provided that an antlerless deer is also killed for each buck. Buck tags can be used during all archery and gun seasons in an IHZ. Hunters without a buck tag can harvest a buck if they first harvest an antlerless deer and the antlerless deer is transported along with the buck to the registration station, in this case, a Zone T tag, license carcass tag, or earn-a-buck tag can be placed on the buck.

Either-Sex Regulation. The rule proposes that the hunting season framework change from earn-a-buck to either-sex when the overwinter deer population is reduced to five or less deer per square mile of deer habitat in an IHZ.

State Park Seasons and Refuges. For parks in an IHZ, the gun and archery hunting seasons would run from the Zone T opening date in late October to the 3rd Sunday after the Thanksgiving Holiday. Parks in urban areas and parks that are primarily designated use areas would not have hunting seasons; government shooters would be used instead. Waterfowl refuges in an IHZ would be open to deer hunting during the gun and archery seasons. Opening of state parks and other DNR properties normally closed to deer hunting is expected to increase deer harvest and prevent refuge situations where deer and CWD would otherwise be protected.

Firearm restrictions. The rule proposes that rifles be allowed in all areas of an IHZ. Rifles are more accurate at longer distances, so deer harvest is expected to increase per unit of effort in an IHZ where rifles may not have been allowed.

Landowner Permits. Landowners and their guests hunting under authority of landowner permits would be exempted from the hunting license requirement and from regular deer hunting season date restrictions only for the land and the time period, for which the permit is issued. Exempting landowners and their guests from the licensing requirement, if they have a permit for their property, would be expected to increase hunter numbers and therefore harvest. Exemption from the regular deer hunting seasons would allow for increased opportunities to harvest deer throughout the year. The DNR may authorize landowners and their agents to shoot over bait by permit in an EZ. These permits would allow landowners to be cooperators with the DNR in winter removal operations. Permit conditions would ensure that baiting only be done in controlled situations and with performance expectations.

Registration and Transportation. The rule further proposes that any deer harvested in an EZ and IHZ would have to be registered at a deer registration station designated by the DNR within these zones no later than 5:00 p.m. on the day after it was killed.

Agency Shooters. Agency shooters would assist with the depopulation of deer by shooting over bait, at night, and from motor vehicles. Shooting would take place on DNR-owned lands, and on private lands where the landowner grants permission.

Aircraft Use. This rule would establish the conditions under which aircraft may be used for shooting deer (December 1 – April 15). Aircraft could be used to spot, rally or drive deer. Deer could be harvested from an aircraft only on properties where the DNR has received landowner approval. Aircraft may be used for other purposes any time of the year. This special authorization would expire June 30, 2004.

Effects.

Deer herd reduction and hunter behavior. Public hunting is believed to be the most effective method of herd reductions due the large numbers of hunters and their access to both public and private lands in an IHZ. The long seasons are offered to give hunters every opportunity to reduce the deer herd as much as possible. The proposed IHZ gun season would begin about the time of leaf fall for safety purposes and would end mid-winter to allow maximum days for hunter participation.

The earn-a-buck regulation is believed to be the most effective regulation for herd reduction (DNR, unpubl. data). It allows those who are willing to shoot both bucks and antlerless deer to continue to do so. Most importantly, however, it requires those who prefer to shoot only bucks to shoot antlerless deer as well. In the current EZ area, unit 70A had an earn-a-buck regulation in 1996. In that year, the registered harvest was 46 deer per square mile, far higher than any other year under any other regulation. In 1999, 2000, and 2001 Zone T regulations only resulted in 23, 31, and 19 deer harvested per square mile of deer habitat respectively in unit 70A. The ratio of antlerless deer to bucks harvested during the 1996 earn-a-buck season went from about 1:1 to 4:1 (DNR, unpubl. data). The difference between the proposed rule and 1996 is that hunters would be allowed to earn an unlimited number of bucks rather than just one buck for each license held, as long as they shoot an antlerless deer for each buck. The ability to earn multiple bucks is expected to increase the buck harvest as well as the antlerless harvest. Questionnaire results showed 45% supported and 55% opposed this controversial regulation (Appendix D).

Although all of these regulations have the potential to result in successful herd reduction, success would ultimately depend on hunter participation and willingness to shoot more deer than ever before. This may be difficult for hunters when they may not desire additional venison. During the fall 2003-2003, deer seasons in the EZ and IHZ established in the CWD Emergency Rule, 30 deer per square mile of deer habitat were harvested, which is lower than the 1996 harvest in 70A, when 46 deer per square mile of deer habitat were harvested utilizing the earn-a-buck regulations. However, until data from the 2002 CWD deer hunter survey are analyzed (Petchenik, in prep.), it is not certain whether concerns about CWD was a factor limiting participation and harvest.

Public safety. Some landowners and recreationists have expressed concern about safety for them, their family, their livestock, and their pets during the long gun season. Having a more than three month gun season logically adds risk to that provided by a nine-day gun season. The degree of added risk is impossible to predict. However, there would likely be fewer deer hunters in the woods on any given day than during the intense nine-day gun season. Landowners can control who and how many hunters are on

their land. Most hunting accidents involve self-inflicted injuries or hunters accidentally shooting their partners (Wisconsin Deer Harvest Report 1990 to 2001). It is an extremely rare event for non-hunters, livestock or pets to be shot by a deer hunter, even when over 700,000 hunters are in the woods on the traditional opening weekend. The late October Zone T season has been used annually as a herd management tool from 1996 to the present without hunters shooting other hunters or non-hunters. During the 2002 IHZ hunting seasons there were no fatal accidents.

The rifle allowance in an IHZ would only be new for those counties not located in an area of the state where the use of rifles is prohibited. Hunting accident records over the past decade show that rifles are not involved in more hunting accidents than shotguns (Wisconsin Deer harvest Report 1990 to 2001). Currently, counties that have rifle restrictions are located in the more highly populated southern part of the state and in a highly populated area in Pepin County.

Agency shooters would receive specialized training in marksmanship and safety procedures. A shooting plan would be developed for each property where permission from the landowner was granted, and would include an on-site visit and mapping of the property. Scouting to assure safe shooting lanes would also take place prior to shooting.

Trespass. Hunters are still required to get permission from landowners to hunt on their lands in the CWD zones. Trespass laws still apply. It is possible that some hunters would perceive the mission of CWD as over-riding this law and rationalize trespass. On the other hand, many would not see deer in this area as valuable as in the past and may not to take the risk of trespassing. In 2002, during the EZ and IHZ hunts there were fewer instances of trespass in the Iowa County portion of the current IHZ than in previous years, and no increase in trespass complaints in the Dane County portion (Dane and Iowa County Sheriff Departments, pers. comm.)

Recreational and Land Use Conflicts. There is potential for many recreational conflicts to be caused by the proposed hunting regulations. Hunters that normally are not required to wear blaze orange would be required to do so during the longer gun deer season. It is unclear what effect the blaze orange requirement had on fall turkey hunter success in the portion of turkey management zone 4 that was located in the current IHZ (the eastern half of the turkey management zone 4 was located in the current IHZ), however, preliminary 2002 fall turkey harvest data shows that the percent hunter success for the entire turkey management zone 4 was unchanged from last years success rate. Some hunters may decide not to hunt with a dog for fear of another hunter mistaking their dog for a deer. Waterfowl hunters would not be required to wear blaze orange, but they may choose not to hunt because of concern for not being seen by a gun deer hunter. Bowhunters are used to hunting the rut by themselves without sharing the woods with gun hunters. Muzzeloaders would not have their own season separate from the gun season. Hikers, bicyclists, and skiers may choose not to recreate in the longer gun season because of concerns for safety. Snowmobilers may have trouble getting access to trails for maintenance before the ground is frozen. In addition, snowmobile clubs may not be able to open trails, as some landowners may wish to prohibit snowmobiling while a deer season is open. Some local residents may choose not to take walks on their lands or on area roads due to concerns about safety. Some people may choose not to use parks in an IHZ while the gun seasons are in place. Landowners may grow weary of hunters asking permission to hunt on their lands or of trying to manage potential conflicts between hunters and their farm operations. Hunters may be more likely to damage some standing crops that have not yet been harvested during the early part of the hunting season. Landowners may perceive the need to keep livestock off their pastures for longer periods of time to ensure their safety. However, considering the low densities of hunters that are predicted to be in the woods at any one time over the course of the season, many who initially think they would not recreate or use their lands in certain ways may choose to do so.

Enforcement. The regulations proposed in this rule would be enforceable based on past experience. However, the longer seasons and complexity of regulations in an EZ and IHZ would place a significantly greater workload on enforcement personnel through responding to questions and tips and field checks of hunters.

DNR Revenue. The proposed rules and policies would reduce DNR revenue as landowners and their guests hunting under the authority of a landowner permit in an EZ would not need to buy a license. It is not known how many licenses would not be bought as a result of this policy. IHZ hunters would not need to

apply for Hunter's Choice/bonus permits, thereby resulting in a loss of application fees. In addition, IHZ hunters would receive free permits so they would not need to purchase bonus tags to harvest additional antlerless deer. Bonus tag revenue would decline for the affected deer management units (Appendix E). Bonus tag revenue is ear-marked for the wildlife crop damage compensation and abatement program. It is possible that revenue would not be sufficient to pay for abatement and compensation. However, with a greatly reduced deer herd in an IHZ, damage claims may also decrease substantially.

DNR Staffing and Expenditures. Long gun seasons would increase staffing needs and expenditures as a result of registration station staffing needs, particularly in an IHZ where staff would attempt to collect the head of every deer harvested. The free tags, earn-a-buck rule, and long seasons would produce more deer to be registered, however, once the population goals are neared or reached, annual harvests and registrations would decrease along with associated costs for sampling and registration. Staff time and expenditures would increase due to issuing landowner permits and use of agency shooters. Customer service, wildlife management, licensing, and law enforcement staff would have to spend more of their time answering questions or giving presentations to groups on the new hunting regulations.

Local Commerce. It is unknown to what degree this rule would impact local economies in an EZ and IHZ. Hunting and other types of outdoor recreation contribute significantly to local economies (Vander Zouwen, 1998). Lengthened hunting seasons may result in increased expenditures in local communities if hunter numbers remain unchanged or increase and hunters increase their number of days in the field. On the other hand, other types of recreation and associated expenditures may decrease if recreationists do not spend time outdoors in an IHZ due to concerns about safety or other conflicts with deer hunting.

Analysis of Alternative Depopulation Tools.

Traditional Seasons or Modest Season Extension. Traditional seasons have not kept deer populations at established overwinter population goals in many units during many years in the last decade (R. Rolley, pers. comm.). Traditional seasons, even with October and December Zone T seasons, will certainly not encourage or allow adequate harvest to meet CWD control goals in an IHZ (approximately 100% herd reduction). Similarly, a somewhat longer season is not expected to generate enough harvest. It is believed that hunting through the rut period, through the Christmas holiday week when many are on vacation and through much of the snow period when deer are more vulnerable is needed to achieve the harvest necessary for an IHZ. However, a shorter season would be less costly to administer and enforce and result in less recreational and land use conflicts.

Require Licenses of All Hunters. Requiring licenses of all hunters in an EZ would keep license revenues as high as possible. In 2002 there was a 10% reduction in the sale of deer gun licenses (M. Davis, pers. comm.). DNR costs for controlling CWD are increasing (L. Freitag, pers. comm.). However, the DNR's primary goal is to eradicate CWD. The DNR believes that more people would pursue deer in an EZ if a license is not required on lands where a landowner has a DNR permit, and this would result in more deer harvested. Moreover, people are more likely to be a willing participant in the task of herd reduction, if they are not asked to pay for the "privilege".

Unlimited Either-Sex Tags. The unlimited either-sex deer hunting regulation would likely be the easiest to understand, administer, and enforce. In addition, it was the most preferred alternative of respondents to the CWD control questionnaire. It would also intuitively be the regulation of choice because all deer seen by hunters could be shot without passing up any bucks and without limit. However, the DNR believes that the earn-a-buck regulation would result in more deer harvested and more effective population control, which are the most important performance measures for any regulation in control of CWD. With hunter perceptions of the safety of venison and experience with very low numbers of hunters keeping their deer in the summer hunts, it is expected that many hunters would only shoot bucks and pass on the does and fawns, particularly if they had not accepted the depopulation goal. Also, with hunter expectations that many of the deer would be gone at the end of the winter, the DNR expects that many hunters would want to take as many bucks as possible before they are gone. An earn-a-buck regulation ensures that a doe or fawn is shot for each buck harvested, which would not likely occur in an unlimited either-sex hunting regulation. At focus groups with EZ landowners conducted in April 2002, many supported the either-sex tag option as they said they would shoot any deer they saw. Many also suggested, however, that their guests would probably need the earn-a-buck regulation to get them to shoot does and fawns as well as

bucks in this situation (J. Petchenik, unpubl. data). Similarly, a local deer hunting guide, a local hunting shop owner, and a number of local hunters who attended the public meetings have suggested that the earn-a-buck regulation would be needed to get hunters to shoot significantly more antlerless deer.

Earn-a-buck with Multiple Antlerless Deer. Some hunters and landowners in current EZ focus groups suggested that hunters be required to shoot two or more antlerless deer for each buck they shoot (J. Petchenik, unpubl. data). These individuals felt that if the goal is to reduce the herd as quickly as possible, it made sense to require hunters to shoot two antlerless deer prior to shooting a buck. This alternative was considered by the DNR both for the 1996 earn-a-buck regulation and the CWD control regulation. It was not adopted because the DNR believes that shooting two antlerless deer per buck would be perceived by hunters as too much of an obstacle, causing them to give up hunting or hunt elsewhere. This regulation would also likely reduce buck harvest. Buck harvest is particularly important due to the greater dispersal tendency of young bucks. This regulation would be more difficult to administer due to the required record keeping on numbers of antlerless deer shot by each hunter.

Use Smaller or Larger Area to Define the Eradication Zone. By adjusting an EZ either smaller or larger, smaller or larger areas would have to be depopulated. A larger zone would be more inclusive of deer movements and would increase the probability of including infected deer that were dispersing. To be completely inclusive, an extreme approach might be taken and the radius used to designate EZs might be based on the longest known dispersal for Midwestern deer (132 mi, Kernohan *et al.* 1994). A 132-mile radius centered on the present EZ would encompass all of southern Wisconsin and adjacent portions of Minnesota, Iowa, and Illinois. Depopulation of an area this large would be difficult for many reasons. Smaller EZs are more easily depopulated and probably more palatable to stakeholders. If we had perfect knowledge of the location of each infected deer, we could make EZs small enough to include only the discrete home ranges of infected deer (approximately one square mile). Unfortunately, we don't know the locations of all infected deer and the technology needed to make that determination (*e.g.,* reliable live tests, tests that detect infection very early in the disease process) is unavailable (Williams *et al.* 2002a), apart from the insurmountable logistical difficulty in capturing and sampling free-ranging deer. As described earlier, the spatial extent (size) of an EZ would be defined on the basis of deer movements and behavior. Scientists on the Interagency Science and Health team, in making a judgment about the appropriate size of the current EZ, had to balance the arguments for making the EZ larger with arguments for making the EZ smaller.

The 4½ mile radius around locations of infected deer is based on an examination of deer movement studies in the Midwest and a judgment that median dispersal distances in southwestern Wisconsin deer are roughly 4½ mile. EZs of this size are thus likely to include most recently dispersed deer. Smaller size risks failure to reduce the spread of CWD by not including dispersing infectious deer. Larger size risks failure to reduce the spread of CWD because depopulation over larger areas is more difficult, expensive, and unpalatable. Recently begun research on the movement and behavior of southern Wisconsin deer is intended to generate movement data for the CWD-infected populations. Ongoing population modeling is analyzing the effective size of an area for eradication of the disease. In addition, ongoing epidemiological research is using test results from the current EZ to characterize the spatial extent of the CWD outbreak. This information may be useful in an adaptive management approach for changing the size or shape of EZs.

Either larger or smaller areas would likely have ecological effects similar to those associated with the proposed rule, but at a different spatial extent. For example, if the current EZ included a larger area, the effects of depopulation would be spread over a wider area, possibly impacting a larger number of species and habitats.

Either larger or smaller areas would likely have socio-economic effects similar to those associated with the proposed rule, but like the ecological effects, at a different spatial extent. If an EZ were expanded to include a larger area, the social and economic effects would expand to affect a larger area and the people and business located in the depopulation area.

Contraception as a Depopulation Method. Immunocontraception is one of several types of contraception that has been proposed as a technique for managing deer at reduced population levels where lethal control is unacceptable. There are, however, currently no cost-effective tools available for the widescale implementation of a contraception plan.

Immunocontraception uses the body's own immune response to disrupt reproductive function. The most widely tested immunocontraceptive vaccine for wild species is based on developing antibodies to the *zona pellucida* which surrounds the mammalian egg cell. This vaccine causes infertility in some individual females but may require multiple treatments. In addition, vaccine adjuvants differ in their abilities to provoke an immune response and prevent pregnancy. Enhancement of the immune response and efficiency of vaccine delivery are needed, because current technology precludes control at the population level in most free-ranging populations. Moreover, contraceptive treatment may alter the health and behavior of wildlife populations, and thus effects must be monitored closely (Muller *et al.* 1997, Miller *et al.* 1998, Walter *et al.* 2002).

Hobbs *et al.* (2000) used modeling to analyze the feasibility of using fertility control (*i.e.* contraception) to regulate the size of an ungulate population. They paid special attention to the problems of variation in the duration of fertility control agents and to inefficiencies associated with knowing the fertility status of animals in the population. They offer five predictions: 1) more than 50% of fertile females need to be maintained as infertile to achieve meaningful population reduction, even when reproductive rates are low; 2) the relationship between the proportion of females maintained infertile and population abundance is highly non-linear such that small errors in estimating fertility can lead to large errors in achieved population density and a broad range of contraceptive delivery rates may differ little in their ability to alter population growth; 3) the effectiveness of fertility control as a management technique depends strongly on the persistence of the effect of the fertility control agent and on the ability of managers to recognize previously treated animals; 4) fertility control using long-lived agents in long-lived animals may be more efficient (in terms of animals treated) than killing in regulating ungulate populations; and 5) treating small populations with permanent fertility control agents increases the risk of extirpation.

Hobbs *et al.*'s (2002) predictions 1-4 are relevant to analysis of contraception as an alternate depopulation technique in the CWD EZ and IHZ. The pre-hunt population of 25,000 deer in the current EZ may consist of more than 10,000 adult does and more than 5,000 fawn does. If half of the fawns are reproductively mature, there may be more than 12,500 reproductively fertile females - more than 6,000 of which would need to be captured, treated with a contraceptive agent, and monitored to achieve negative population growth. Even if all fertile females could be treated with a contraceptive agent each year, the rate of reduction in the population would simply revert to the background mortality rate (15-40% for farmland does [Nixon *et al.* 1991]). Moreover, failure to mark and monitor treated females in a population of this size introduces inefficiency associated with re-dosing individuals such that the number of contraceptive doses administered randomly in order to achieve a needed level of infertility will exceed the population size (Hobbs *et al.* 2002). Finally, long-duration contraceptives are not yet available. Given real-world logistical constraints, and considering efficiency as the amount of time required to bring an ungulate population to an acceptable lower density, Hobbs *et al.* (2002) conclude that, "There is no question that removal is more efficient than fertility control". Given the costs associated with trapping, treating, and monitoring large numbers of deer over several years, depopulation through contraception cannot be cost-effective.

Given the logistical difficulty of contraception as a depopulation technique (Hobbs *et al.* 2002) , it is unlikely that depopulation can occur using contraception alone. Hence, there would be none of the disease-control benefits associated with depopulation . Even if full contraception of all fertile females were possible, the deer population would still take many years to reach zero. Presumably, CWD would continue to infect the residual deer and possibly spread. Under this scenario, shedding by additional clinical animals and unrecovered carcasses would provide a source for environmental contamination by the CWD infectious agent - possibly to the point that eventual restoration of the deer herd is precluded (Williams *et al.* 2001).

A potential effect that is unique to some contraception alternatives is the presence of the contraceptive chemicals in the environment. Contraceptive agents and their metabolites are likely to be endocrine disrupters – chemicals that can mimic hormones in that they can interfere with cellular function at extremely low concentration. Contraceptive agents and their metabolites could enter the environment from unconsumed bait (if bait were a contraceptive delivery technique) or through metabolites shed in the urine

or feces of deer. Human birth-control chemicals in sewage effluent have been implicated in the feminization of fish (Jobling and Sumpter 1994), demonstrating that cross-species effects are possible and community-wide effects are difficult to predict. Although the potential for effects due to very low concentrations of these chemicals in the environment are controversial, the scale at which contraceptive chemicals would need to be used to depopulate an EZ deer herd (above) suggests that a formal risk assessment should be done if contraception were attempted (W. W. Bowerman, Dept. of Environmental Toxicology, Clemson University, *pers. comm.*).

Where contraception has been used in attempts to reduce populations of urban white tailed deer, it has proved enormously controversial (Kirkpatrick and Turner 1997). Stakeholders who oppose killing deer often hold unrealistic expectations for the effectiveness of contraception and are disappointed or angry when their expectations are not met. Hunters often view contraception as a technique that displaces them from recreational hunting and from their role as cooperators in agency efforts to reduce deer populations. Finally, agency administrators find that the costs of treating deer, re-treating and monitoring deer, and monitoring the population response are prohibitive. Kirkpatrick and Turner (1997) suggested that, while the absolute costs of the scientific effort were small ($50 per deer), associated costs in dealing with logistical problems and social controversy can be much higher (thousands of dollars/deer).

Depopulation Using Only Public Hunting. The Wisconsin DNR and most other state agencies rely on public hunting to manage deer populations over large regions. Yet, despite hunting season frameworks designed to foster a more aggressive harvest (*e.g.* T-zones, earn-a-buck), recreational hunters have been unable to achieve population goals in most units and the region itself has had post-hunt deer populations significantly higher than goal since 1990 (Wisconsin Dwpartment of Natural Resources 2001). In Wisconsin's southern farmland region (the region surrounding the current EZ and IHZ), the ecological carrying capacity may be very high (greater than 150 deer per square mile) due to mild winters and abundant agricultural food. Population goals range from 10-30 deer per square mile.

The principle limitations in achieving complete depopulation are the presence of refuge areas for deer and the increasing effort associated with harvesting an individual deer from a low density population (Ridpath and Waithman 1988, Saunders and Bryant 1988, Hone 1990, Choquenot *et al.* 1999). Analysis of Midwestern data on the interaction between white-tailed deer and deer hunters suggests that the effort required to harvest an individual deer becomes asymptotic at 10-15 deer per square mile (Van Deelen and Etter, in press). Recreational hunting is inefficient because of spatial refuges for deer created by landowners who are unwilling to allow hunting and by terrain that may be inaccessible or unsafe to hunt (*i.e.* a small woodlot with a house). In addition, recreational hunters do not hunt systematically (Broseth and Pederson 2000). Some areas are hunted heavily while others are avoided either intentionally or by accident, creating additional refuge areas for deer. Given these conditions, although hunting is a crucial tool in the depopulation of the deer herd, it's unlikely that recreational hunting by itself would achieve densities below 10 - 15 deer per square mile.

In 1972, the DNR used public hunting to depopulate the DNR Sandhill Wildlife Area deer herd in 30 days. This occurred under the following conditions: 1) fenced area of 9,000 acres of deer habitat; 2) excellent public access with no private land; 3) very liberal hunting regulations (*i.e.* all deer were legal game and considered "bonus" deer); 4) hunters were extremely persistent in trying to bag a deer; 5) each day brought a new group of hunters; and 6) hunting pressure was continuous, averaging 138 hunters per day (11 hunters per square mile). Even under the best possible conditions, it took continuous hunter pressure of 11 hunters per square mile to depopulate a deer herd in an enclosed public area (Kubisiak *et al.* 2001),

CWD in free-ranging cervids in Wyoming and Colorado continues to persist at roughly 3% prevalence despite cervid densities in affected populations that are roughly five animals per square mile (Miller *et al.* 2000). Since recreational hunting is unlikely to achieve depopulation and may not achieve sufficient deer population reduction, recreational hunting by itself is unlikely to facilitate complete disease control.

The economic effect of public hunting is likely to be positive because a high percentage of the material and services needed to support public hunting would likely be purchased locally (*e.g.,* ammunition, fuel, restaurants, hotels). Moreover, expanded public hunting received considerable support from local residents at recent (Nov. 15-16) public meetings (Wisconsin DNR, unpubl. data). On the other hand, some

local residents seek relief from deer hunting and hunting related activities because of unwanted disturbance on the landscape and perceived safety threats.

Depopulation Using Only Landowner Shooting. Successful depopulation by landowner shooting is subject to the same constraints relative to refuges and hunter effort as was discussed under the previous "public hunting" alternative . While landowners may enjoy complete access to their or their neighbor's land, they likely would have the same difficulty accessing other private land as do public hunters. In addition, there are lands that would not be hunted because of absentee landowners, landowners who do not hunt, and landowners who disagree with the management goals and techniques of the CWD eradication plan. Thus, it is unlikely that landowner shooting by itself would accomplish depopulation.

Since March 6, 2002 (the earliest response to Wisconsin's CWD outbreak) the Wisconsin DNR has issued special permits to cooperating landowners in the current EZ. These permits were offered free and have been critical in achieving both meaningful samples of deer tissues for surveillance and for achieving general deer population reduction. Continued reliance on landowner shooting could continue as is, or offering a financial incentive could enhance shooting by landowners.

The social effects of relying on landowner cooperation for all or part of the depopulation are likely to be substantially positive. Landowner-based herd reduction strategies were clearly the preferred options at public meetings held in the current EZ and IHZ. Apart from providing financial incentives to landowners, economic impact would presumably be positive as well because goods and services purchased to support landowner shooting would likely be purchased locally. Presumably, some businesses such as restaurants and motels would receive fewer benefits than they would under the public hunting alternative.

Landowner Incentives. The use of landowner incentives would generate many unique socio-economic effects (A. Nelson, DNR unpubl. memo, November 12, 2002). The idea of providing cash payments to landowners to remove deer from their property arose soon after the decision to remove all deer from the current EZ was made. While most EZ landowners are cooperating with disease control efforts, support is less than unanimous. Many landowners (or their designees) would stop short of killing every deer on their property for one reason or another. The DNR must anticipate that some landowners would not participate at all, providing refugia for deer and the disease.

Currently, the DNR does not have the legislative authority to establish landowner payments for removing deer. In addition, a funding source would need to be identified that would be able to support not only payments in the current EZ, but over larger areas should new zones be established. This may also set a precedent that participants in DNR wildlife damage programs would expect payment for routine deer control.

Submission of animals from outside the target area, misrepresentation of non-target animals or parts, and other frauds have historically plagued efforts to reduce wildlife populations through the use of financial incentives. Verifying deer kills with landowners and making payments only to them may reduce opportunities for fraud by hunters, who would need direct cooperation of an EZ landowner to profit, although this places additional burdens on DNR staff workloads.

Besides fraud, past efforts to use financial incentives often failed because individual payments and annual budgets were inadequate to ensure that annual harvest exceeded annual population increases, resulting in no net progress in population reductions from year to year. Regular annual programs also gave hunters and trappers an incentive to save breeding stock for next year to keep money coming. Similarly, there is some legitimate concern that payments would cause landowners and their hunters to compete for the opportunity to kill deer that reside on multiple properties.

Finally, it may not be possible to completely indemnify the DNR from liability for injuries resulting from landowner compensated deer removal, unless legislation is passed that would free the DNR of liability under certain circumstances. This legislation would eliminate DNR liability and could require a landowner to accept responsibility for any hunters he or she utilized to take deer off their land as a condition of payment.

Depopulation Using Only Agency or Contract Shooting. Although most studies of non-traditional methods for deer herd reductions have taken place in urban settings, these reports clearly demonstrate that, aside from public hunting, shooting over baited sites is the most cost-effective, efficient, and safe method for removing large numbers of deer. Because of these attributes, the Southeast Wisconsin Urban Deer Task Force (Urban Deer Task Force. 1994) ranked shooting highest among all other options for herd reductions. Non-traditional methods proposed by the DNR to assist depopulation efforts include: 1) shooting from fixed positions, 2) using aircraft or trailing hounds to drive deer to ground-based shooters, 3) shooting from aircraft and vehicles, and 4) live-capture (*i.e.* snares, box traps, rocket nets) and euthanasia. Each of these methods have been used, under various management applications or research protocols, for deer herd reductions. The relative cost and efficiency of many of these methods have been documented in the literature (Palmer *et al.* 1980, Ishmael and Rongstad 1984, Ishmael *et al.* 1995, Jordan *et al.* 1995, DeNicola *et al.* 1997, DeNicola *et al.* 2000).

During the past 20 years, shooting over baited sites has become a commonly-used approach for reducing urban deer populations in the midwestern and northeastern states due to it's recognition as a safe, efficient and cost-effective method. During the winter of 2001-02, 12 Wisconsin municipalities or institutions used shooting over baited sites to remove deer. Contractors providing shooting services to these municipalities report removing as many as 46 deer in one four-hour nighttime period using four sharpshooters with sound suppressed firearms (Urban Wildlife Services, Inc. report to City of Altoona 2000) and as many as 23 deer from one baited site over a three-hour shooting session (B. Ellarson pers. comm.). Contractors in Iowa City, IA removed 382 deer in 10 days with three shooters. Removal of greater than 10 deer per bait site per evening shooting session is common. Sharpshooters may average 12.75 deer per day per shooter. The efficiency of bait and shoot operations tends to decline as deer numbers are reduced and the remaining deer become wary of baited sites. Jones and Witham (1995) reported removal rates via shooting of 62.5 minutes per deer during the first year but 108.1 minutes per deer during the third year of deer removal on Chicago metro forest preserves. However, infrequent or short-duration shooting sessions (*i.e.* one to two consecutive nights/week) allow remaining deer to become re-accustomed to bait sites and, therefore, are more cost-effective than more frequent shooting sessions per bait site. Recent deer shooting programs demonstrate that high numbers of deer can be removed with relative efficiency but it is likely that relatively small numbers of residual deer would still need to be removed by more intensive (and expensive) methods.

The effectiveness of agency shooting is limited by refugia created by landowners who are not supportive of CWD management techniques. There is also a point of diminishing return that is reached when deer populations are low. Agency shooters would have to spend increasing amounts of time to shoot deer as populations are reduced. Also, the number of agency shooters with appropriate training is limited, thus the effort needed to facilitate full depopulation would be difficult. Agency shooting, unless used in conjunction with other techniques, would be unlikely to achieve depopulation within 4-5 years.

The current EZ in southwest Wisconsin has abrupt topography, limited road access, scattered residential development, and is predominantly agricultural land posing geographic and logistical limitations to aerial gunning, shooting from vehicles, and live-capture/euthanasia. Aerial gunning, although used successfully on mule deer in the more open and lightly-developed range lands of western states, may prove to be relatively expensive and ineffective at removing large numbers of deer due, primarily, to gaining the consent of local landowners, public perception regarding the safety of shooting near rural residents and stress and safety to livestock, and limitations of vehicle access to retrieve downed deer on remote, steep, snow-covered, and wooded terrain. However, even with these limitations, use of aircraft may be needed should other alternatives prove unsuccessful in depopulation of deer in an EZ.

Spotlighting and shooting from vehicles can be a relatively safe and efficient method for herd reductions or sample collections near CWD affected areas. These methods are effective in leaf-off conditions, especially with snow cover when deer are more visible. These methods also work well when deer are feeding in agricultural fields. However, deer become sensitive to spotlighting and learn to run when shined. Deer also tend to avoid fields at certain times of the night if spotlighting is done during the same time period each night. Agency shooting over bait is cost-effective relative to other methods involving aircraft charter, large numbers of personnel for drives or carcass removal, or single-deer capture/euthanasia methods.

Nonetheless, the costs of a multi-year program relying solely on agency shooters to achieve complete depopulation would be prohibitive for agencies providing the shooters. In addition, many of the positive benefits of public hunting and landowner shooting (discussed earlier) would be precluded.

Social impacts of agency shooting are more difficult to predict. Some stakeholders would perceive agency shooting to be a safer alternative to public hunting or landowner shooting because of the specialized training required of agency shooters. Others would be unhappy with the loss of hunting opportunity and the emphasis on government-driven actions. The use of aircraft to drive deer would be highly visible and would likely generate considerable controversy and criticism from area residents and farmers with pastured livestock. The potential for public visibility and community disturbance seems relatively low because shooting over bait usually takes place during nighttime or early morning hours during winter months when outdoor human activity is at a minimum. Bait/shooting sites can be established at locations that are not visible from public roadways yet are close enough to allow for easy removal of carcasses. Shooters would work alone (radio or cell phone contact with DNR staff) and would be stationary in elevated stands at the bait site. With adequate snow cover and lighted-reticle telescopic sights, nighttime shooting can be done safely.

Depopulation Using Live Capture and Euthanasia. Another alternative method of depopulation is using live capture and euthanasia. In practice, euthanasia following live capture has rarely been used for depopulation or population reduction in deer. Live capture and euthanasia is an inefficient way to kill deer, because deer trapping is very labor intensive. Trap sites need to be pre-baited up to a week before trap placement to begin attracting deer. The attractiveness to deer of a baited trap depends to some extent on the availability of alternative food nearby. Consequently, successful deer trapping generally occurs during the late winter and spring when natural food is relatively scarce and deer are likely to be food-stressed (Rongstad and McCabe 1984). The current EZ and IHZ of southern Wisconsin is a mosaic of forest patches and agriculture. The ready availability of waste and unharvested grain, apples, alfalfa, and other agricultural food makes it difficult to entice local deer into commonly used deer traps. This is already a serious obstacle for CWD-related telemetry research in the current EZ and IHZ (T. Van Deelen, pers. observ.).

Even when deer are entering traps, traps must be checked daily, must be maintained and re-baited as needed, and must be removed when trapping success declines to the point that captures stop. In the cases of net-gunning, dart-gunning, and drop-netting, a great deal of personnel time must be spent waiting for deer to arrive at a bait site and position themselves for effective capture. All of these activities must occur during a relatively narrow temporal window (late winter – early spring) when baiting is effective. Moreover, deer differ in their propensity for capture, some readily enter traps sites while others are more cautious (Rongstad and McCabe 1984, Schemnitz 1996). Thus, when trap success for a site drops to zero it is likely that not all the local deer have been captured.

Given these inefficiencies and related expenses, it is unlikely that depopulation could be achieved through live capture and euthanasia alone. Live capture and euthanasia may be a useful technique where deer populations are small and insular and agency shooting or public hunting are not an option (*e.g.* small urban parks).

Some stakeholders concerned with humane treatment of deer consider live-trapping and euthanasia to be a more humane alternative to shooting. Simple confinement can be a source of stress for wild deer and can result in injury and death (3-15%) if deer struggle against immobile traps (Rongstad and McCabe 1984).

Similarly, snares or cable restraints can be constructed and used in a manner to reduce or avoid strangulation or injury. These techniques can be relatively selective for a target species and could be used in areas that would minimize non-target captures. However, the use of these tools is likely to be controversial because of the perception that it is inhumane or non-selective. Cable restraint and euthanasia was not a preferred option by participants at a public meeting on CWD herd reduction strategies.

The largest impact of a trapping and euthanasia program would be cost. Trap construction or purchase, bait, euthanasia agents, and personnel costs are likely to be a poor use of funds considering the modest deer population reduction achieved.

Depopulation Using Toxicants. The final depopulation alternative assessed is the use of environmental toxicants or poison. In the U.S., use of chemical toxicants to control or depopulate populations of nuisance wildlife is commonly used for rodent pests of agriculture and less commonly used for other applications. In Australia and New Zealand, toxicants have been used to control a large number of feral vertebrates (Veitch 2000).

This technique is rarely used on large mammals and currently there are no EPA-registered toxicants available for use on white-tailed deer. Some toxicants (*e.g.* Compound 1080, strychnine) have wide applicability for vertebrates and the EPA does allow their use for emergency applications but approval may still be unlikely (R. Schmidt, Utah State Univ., pers. comm.). A major barrier to the use of toxicants is the inability to selectively deliver the toxic agent to deer without impacting non-target species. Research on this question has been driven by the desire to deliver oral contraceptives using treated bait. A variety of treated foods and mineral supplements have been tried to deliver pharmaceuticals and biomarkers to deer (Mason *et al.* 1997, Linhardt *et al.* 1997), though most are equally attractive to other herbivores.

In theory, large numbers of deer could be killed cost-effectively using toxicants, although practical use of this technique is precluded by the risks that toxicant-loaded baits pose to domestic animals, humans, and non-target wildlife. Secondary poisoning can occur if predators and scavengers ingest contaminated tissues from a poisoned herbivore.

Use of toxicants is likely to be relatively inexpensive because it is less labor-intensive. That said, risks to non-target animals, possible contamination of the environment (uneaten treated baits, unrecovered contaminated carcasses, and toxicant metabolites), and perceptions that poisoning is inhumane suggest that widespread use of toxicants would be highly controversial. Uncertain delivery and dosage control suggests that sublethal dosages may occur in deer as well as non-target animals thereby raising additional animal welfare concerns. Application of toxicants requires the cooperation of private landowners and, given the potential for controversy and unintended effects, not all landowners can be expected to cooperate. Hence, one could expect the creation of refuge areas resulting in inefficient disease control.